Iowa Department of Natural Resources

WELL RECORD FORM

Geological and Water Survey

PWTS No. *or* PWS No. _____ | PWTS Permit No. _____ | GEOSAM Well No. *(DNR use only)* 62640

Site Identification

Property owner SIOUX CITY, IA. DEPT. WATER SOUTH BRIDGE Other ID C. W.

Address 1101 TRIVIEW AVE City SIOUX CITY, IA 51103

Tenant _____

Well depth 140 ft Date completed PUMPING TEST 3 1/16/11

Location

County WOODBURY

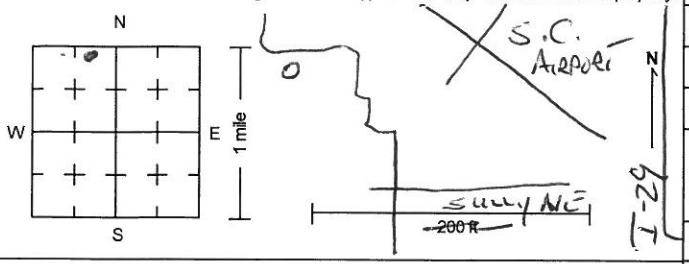
GPS coordinates (NAD83 datum)

42° 23' 56.8" N Latitude 96° 24' 23.9" W Longitude

☐ Decimal Degrees ☐ Degrees, Decimal Minutes ☒ Degrees, Minutes, Seconds

NE 1/4 of the NE 1/4 of the NW 1/4 of Sec 36 TWP 88 RNG 48 E (W)

Show exact location of well in section grid with a dot (•). Sketch map of well location on property.



Formation Log

From	To	Color	Hardness	Formation description
0	2	BRN		SILTY SAND, TOPSOIL
2	31	BRN		SILTY SAND & SAND
31	37	BRN		SAND & GRAVEL
37	60	GRAY/BRN		SAND
60	64	GR/BR		SAND & GRAVEL
64	68	D.GR.		CLAY, COBBLE
68	77	LT. BR.		SILTY SAND
77	85	GR. BR		SAND & GR
85	93	GR.		SAND
93	99	GR.		CLAY W/ SAND LAYERS
99	110	GRAY		SAND
110	118	GRAY		SAND & GRAVEL
118	125	GR. BRN		SILTY SAND & GRAVEL
125	132	GR		SAND & GRAVEL
132	135	GR.		SAND W/ GRAVEL
135	140	GR.		SAND & GRAVEL

(use additional sheets as needed)

Remarks (including depth of lost drilling fluids, materials, or tools)

8 WELL SCREEN LATERALS; 200' EACH
12" PIPE SIZE 30455 @ 128' DP.

Well Use

☐ Domestic ☒ Public supply ☐ Livestock
☐ Heat pump ☐ Commercial ☐ Irrigation
# of borehole(s) ____ ☐ Monitoring ☐ Other _____

Drill Method

☐ Rotary ☐ Auger ☐ Cable ☒ Other CLAM SHELL CAISSON

Hole size

246 inch from 0 ft to 140 ft
____ inch from ____ ft to ____ ft

~~hole size continued~~ CAISSON OD

246 inch from 133 ft to 140 ft
240 inch from 2 ft to 133 ft

Casing or Loop Pipe

WELL SCREEN

Record all depth measurements from ground level (GL). Use + for above GL measurements.

Size (in)	Material	Depth Top	Depth Bottom	Perforated	Slotted	Screen
				☐	☐	☐ slot size ____
12	30455	125	126	☐	☐	☐ slot size 30
				☐	☐	☐ slot size ↓
	MOSTLY	0.080"-0.15"		☐	☐	☐ slot size ↓
		SLOT		☐	☐	☐ slot size 150

Casing Grout

Placement method TREMIE

Type	Depth top	Depth bottom
BENTONITE GROUT	2	27
BENTONITE FLUID	27	133
☐ Gravel packed variety NO		
☐ Seals/packers		

Pump Installation

Date ___/___/___

Type of pump BY OTHERS Depth to intake _____ ft

Pump diameter _____ in Rated capacity _____ GPM

Water Information

Date 3/15/11

Use + for above GL measurements.

Static Water Level	Pumping Water Level	Yield	Duration
116' ft	29' ft	10,600 GPM	72 hrs

Water level measurement: ☐ Sonic ☒ Tape ☐ Airline ☐ E-line ☐ Estimate

Water yield measurement: ☒ Orifice ☐ Volumetric ☐ Estimate METER

Main water-supply zone from 116 ft to 126 ft below GL

Well Development

☒ Physical explain: BORE BLAST

☐ Chemical explain: _____

Contractor

Company RANNEY COLLECTOR WELLS

Address 6300 HUNTLEY ROAD, COLS, OH 43229

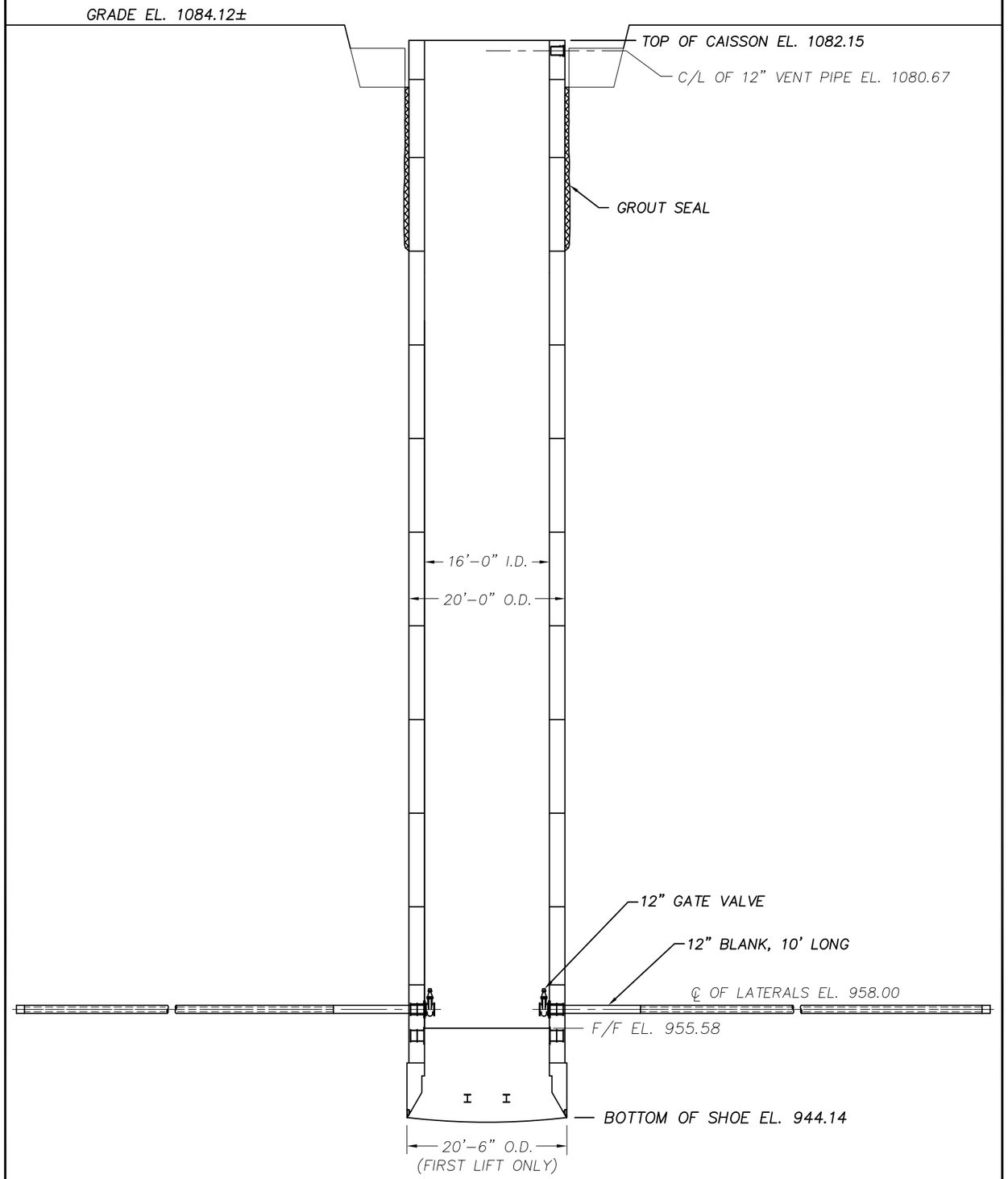
Driller _____ Certification no. 5171

Revision Date: 10/2011

Send form to **Iowa Department of Natural Resources – Geological and Water Survey**
109 Trowbridge Hall, Iowa City, IA 52242-1319 PH 319-335-1575 FAX 319-335-2754

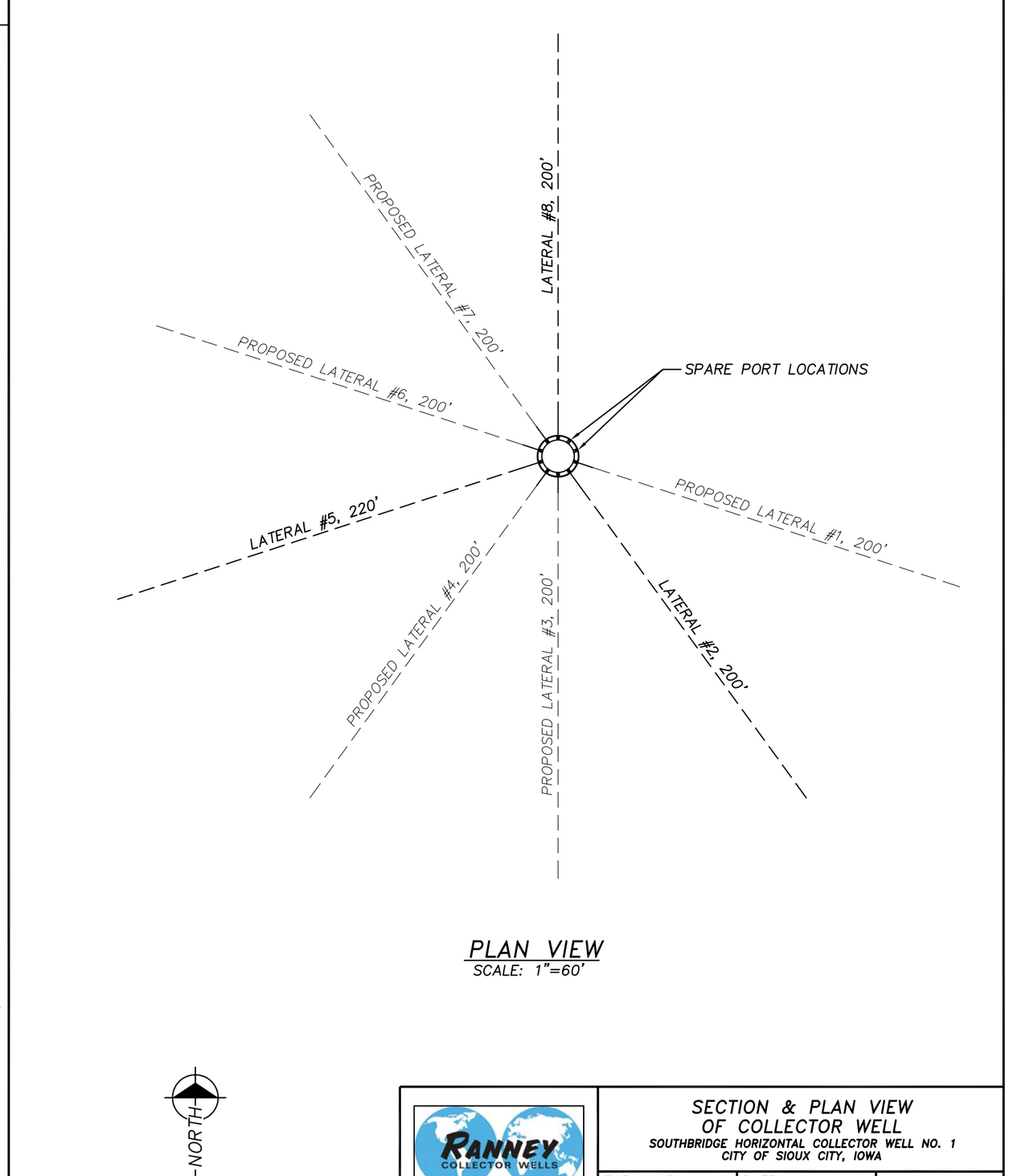
Make photocopies for:
well contractor, customer, and county health department

Received 9/21/12



VERTICAL SECTION THRU CAISSON

SCALE: N.T.S.



PLAN VIEW

SCALE: 1"=60'

NORTH

RANNEY COLLECTOR WELLS
6360 HUNTLEY ROAD
COLUMBUS, OHIO 43229
(614) 888-6263 / FAX (614) 888-9208

SECTION & PLAN VIEW OF COLLECTOR WELL
SOUTHBRIDGE HORIZONTAL COLLECTOR WELL NO. 1
CITY OF SIOUX CITY, IOWA

FILE NAME:	DATE:	FIGURE
7390-05	12/8/10	1
PROJECT #:	SCALE:	
7390	1"=60'	

Received 9/21/12

RANNEY COLLECTOR WELLS

6360 Huntley Road • Columbus, OH 43229 • 614.888.6263

MEMORANDUM

To:	**Russ Bertrand /Brown Construction**
To:	**James Winger, Jeff Henson / Black & Veatch**
From:	**James J. Bell, S. Stowe / Ranney Collector Wells**
RE:	**Caisson Boring Results**
	Southbridge HCW No. 1 - Sioux City, Iowa
Date:	**April 6, 2010**

The City of Sioux City, Iowa (City) is in the process of installing a horizontal collector well to obtain up to 15 million gallons of water per day (MGD) from the Missouri River Alluvial Aquifer in the City's Southbridge Wellfield. This well has been designated as Southbridge HCW No. 1. The City has contracted with Ranney Collector Wells/Brown Construction Company for the construction of HCW No. 1.

Ranney Collector Wells recently drilled a test boring at the centerline of the proposed caisson location per Section 02840 Part 3-1 of the bid specifications. The caisson boring was drilled to establish baseline geologic conditions and to confirm caisson constructability. This memorandum documents the drilling and testing results of the caisson boring by Ranney Collector Wells – Columbus, Ohio.

Caisson Boring

The caisson boring was drilled from March 3 to March 4, 2010. The boring was drilled using the rotasonic drilling method to a depth of 175 feet below grade, encountering weathered bedrock at a depth of 169 feet below grade. The rotasonic drilling method is superior to the previous drilling methods used at the site, in that it provides a 4-inch diameter continuous core of the materials encountered. Continuous samples were obtained in 10 foot runs from grade to completion depth of the boring. Selected samples were collected from the cores and placed in containers at 5 foot intervals or change in formation materials. A log of the materials encountered during drilling and photographs of the samples are included in Attachment 1. Sieve analyses were conducted on selected samples and are included in Attachment 2.

In general, the upper 111 feet of material consisted of fine to medium sand with varying amounts of silt and minor amounts of gravel. A 3½ foot thick medium stiff to stiff clay layer was observed from 64 to 67½ below grade (elev. 1016.6 to 1020.1 feet). A clay layer was also observed at this elevation in previous borings (B1, B2 and B4) drilled near the caisson location. A zone of clay with sand lenses was observed from 93 to 98½ feet (elev. 985.6 to 991.1 feet). The presence of clay layers could potentially cause problems during the caisson sinking process. The material from 111 to 118 feet was comprised of a clean (minimal silt/clay), loose sand and gravel. From 118 to 125 feet, a silty/clayey sand and

gravel was encountered. The silt/clay content appeared to decrease with depth in this interval, with the highest silt/clay content being observed from 118 to 121 feet. The proposed centerline of laterals is 119 feet below grade (elev. 965 feet) and lies within the silty/clayey sand and gravel zone. The attached photograph of the zone from 118 to 121 feet was taken at night and does at accurately illustrate the silty nature of these deposits. The aquifer materials from 125 to 155 feet were comprised of loose sand and gravel that exhibited a coarsening downward sequence. This material appeared to be clean and highly permeable. From 155 to 169 feet a uniform fine to medium sand was encountered. Weathered bedrock was encountered from 169 to the completion depth of 175 feet.

RECOMMENDATIONS

Based upon the caisson boring results, the more permeable deposits are located from 125 to 155 feet below grade. If these conditions are laterally consistent within 200 feet of the boring, it is recommended that the centerline of the laterals be lowered to at least 129 feet below grade (elev. 955 feet) or 10 feet lower than the original proposed centerline. It is our opinion that the permeability of materials at a depth of 129 feet is more than twice those of the deposits at a depth of 119 feet and will result in more efficient installation, capable of producing the desire yield (15 MGD) with up to 50 % less drawdown.

In order to lower the centerline of laterals, the length of the caisson would need to be increased by 10 feet, thereby lowering the elevation of the bottom shoe to an elevation of 946 feet. Increased costs for this would be $ 75,000.00 (seventy five thousand dollars) to account for the additional lift, higher strength concrete for the plug and additional construction costs associated with the increased depth (caisson sinking, materials & equipment handling, increased pressures).

Attachments (Boring Log, Photographs of Samples & Sieve Analyses)

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6360 HUNTLEY ROAD
COLUMBUS, OHIO 43229
614-888-6263

FIELD BOREHOLE LOG

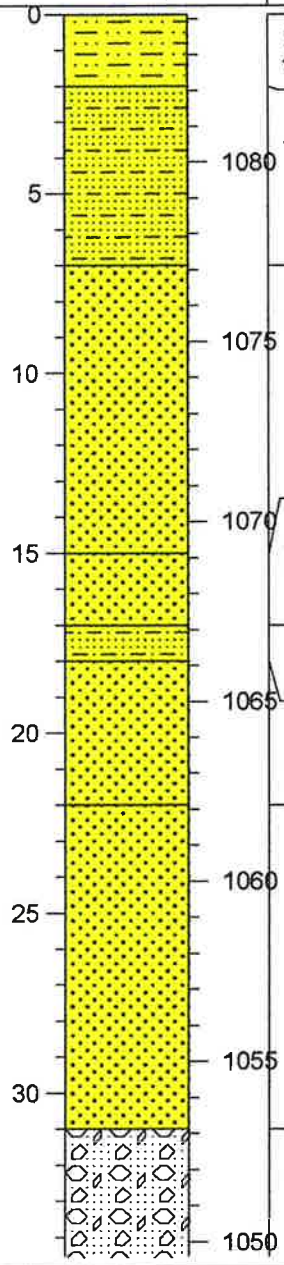
BOREHOLE NO.: **Caisson**
TOTAL DEPTH: **175 feet**

CLIENT: Sioux City, IA / Brown Construction
SITE LOCATION: Southbridge Collector Well Site
Lane extending from Allison Ave.
COORDINATES: N 3622142.45 E 4136528.68
TOP OF CASING ELEVATION:
GRADE ELEVATION: 1084.12 feet

JOB NO.: 7390
DATE DRILLED: 3/3/10 -3/4/10
GEOLOGIST: Jay Bell, Ranney
DRILLER: Mark A., BoartLongyear
BORING DIAMETER: 6-inch
METHOD OF DRILLING: Rotosonic (stnd)

NOTES: Test boring abandoned with bentonite grout

Wentworth Classification System was used.



DEPTH (feet)	ELEVATION (feet)	LITHOLOGY	RECOVERY	WELL CONSTRUCTION	WELL DESCRIPTION
0 – 5	1084.12 – 1080	Brown, Silty Sand to Sandy Silt, moist, topsoil.	0 to 5 feet, 5 feet recovery		
0 – 5	1084.12 – 1080	Brown, Silty Sand to Sand, in layers < 8" thick, sand fine to medium, loose.			
5 – 10	1080 – 1075	Light Brown, Sand, fine to medium, mostly medium, loose, clean, dry.	5 to 10 feet, 5 feet recovery		
10 – 15	1075 – 1070	Brown, Sand, fine to medium sand, w/ thin <0.5" thick dark brown silt lense at 16.5 feet, moist, some staining (water level fluctuations).	10 to 15 feet, 5 feet recovery		
15 – 20	1070 – 1065	Brown, Silty Fine Sand, thin black streaks, holds shape, moist.	15 to 25 feet, 10 feet recovery		
15 – 20	1070 – 1065	Brown, Sand, fine to medium sand, mostly medium, coarsens w/ depth, loose, clean.			
20 – 25	1065 – 1060	Brown, Sand, fine to medium sand, mostly fine, loose, clean.			
25 – 30	1060 – 1055		25 to 35 feet, 8 feet recovery		
30 – 35	1055 – 1050	Brown, Sand and Gravel, medium to coarse sand, mostly medium, 10-20% fine gravel, subangular to subrounded, loose, clean.			

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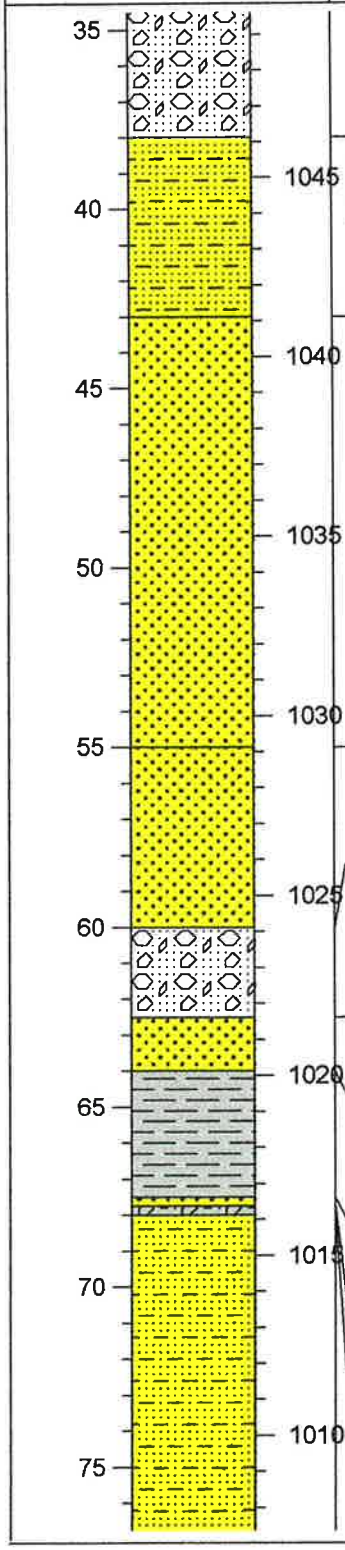
FIELD BOREHOLE LOG

BOREHOLE NO.: **Caisson**
TOTAL DEPTH: **175 feet**



DEPTH (feet)	ELEVATION (feet)	LITHOLOGY	RECOVERY	WELL CONSTRUCTION	WELL DESCRIPTION
			35 to 45 feet, 8 feet recovery		
	1045	Gray, Silty Fine Sand, trace organic material (wood, leave fragments), thin black streaks.			
	1040	Gray/Brown, Sand, fine to medium sand, mostly fine, very little medium, uniform, clean.	45 to 55 feet, 6 feet recovery		
	1035				
	1030				
		As above, slightly coarser material.	55 to 65 feet, 6 feet recovery		
	1025	Gray/Brown, Sand and Gravel, fine to medium sand, mostly medium, trace coarse, 20-40% fine to medium gravel, mostly fine, subangular to subrounded, trace silt, (appeared tight).			
	1020	Gray, Sand, fine to medium, mostly medium, trace silt.			
		Dark Gray, Clay, dense, penetrated 0.25" with thumb in upper section, softer/stickier with depth, 4" cobble at 66 feet.	65 to 75 feet, 6 feet recovery		
	1015	Gray/Brown, Sand, fine to medium sand lense, clean.			
		Gray/Brown, Gray Clay w/ Sand and Gravel, dense.			
	1010	Gray/Brown, Silty Sand, fine to medium sand, trace lignite fragments, uniform.	75 to 85 feet, 10 feet		

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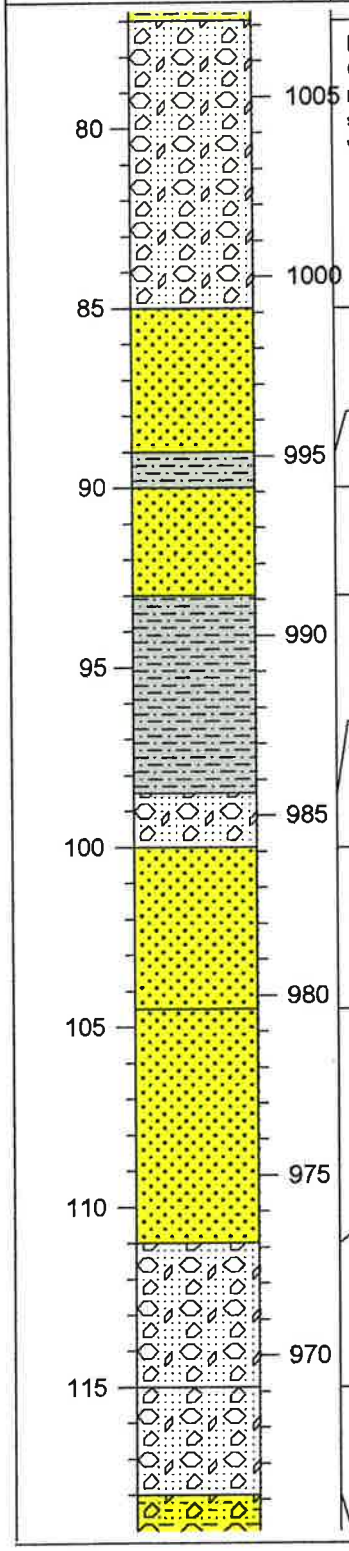
FIELD BOREHOLE LOG

BOREHOLE NO.: **Caisson**
TOTAL DEPTH: **175 feet**



DEPTH (feet)	ELEVATION (feet)	LITHOLOGY	RECOVERY	WELL CONSTRUCTION	WELL DESCRIPTION
		Brown grading to Gray, Sand and Gravel, medium to coarse sand, 50/50 mix, 20-40% fine gravel, subangular to subrounded, gravel content increases w/ depth (40-60% in lower portion).	recovery		
85	1000	Gray, Sand, fine to medium sand, 50/50 mix, coarsens w/ depth, uniform, dense, clean.	85 to 95 feet, 10 feet recovery		
	995	Gray, Clayey Sand, fine to medium sand, dense, 4" cobble.			
90		Gray, Sand, fine to medium, mostly fine, uniform, clean.			
	990	Gray, Clay with Sand Layers, fine to medium sand, 8" clay layer w/ wood at 93.5 feet, Clay content decreases w/ depth, little gravel below 95 feet.			
95		Brown (abrupt color change), Sand and Gravel, medium to coarse sand, 20-30% fine gravel (trace medium), trace silt.	95 to 105 feet, 6 feet recovery, bottom 3' fell out.		
	985	Dark gray grading to Gray, Sand, fine to medium sand, loose, clean. 2" wood fragment at 100 feet.			
100					
	980	Gray, Sand, fine to medium, mostly medium, trace coarse sand/fine gravel, loose, clean.	105 to 115 feet, 10 feet recovery, 1st sample fell out, 4 runs.		
105					
	975	Gray, Sand and gravel, medium to coarse sand, 50/50 mix, 20-30% fine gravel, trace medium, (best 114-115'), loose, clean. Difficulty in getting sample, 4 runs.			
110					
	970	Gray, Sand and Gravel, 40-60% medium to coarse sand, mostly medium, 40-60% fine gravel, subangular to subrounded, loose, trace silt.	115 to 125 feet, 10 feet recovery, overshot casing first to		
115					

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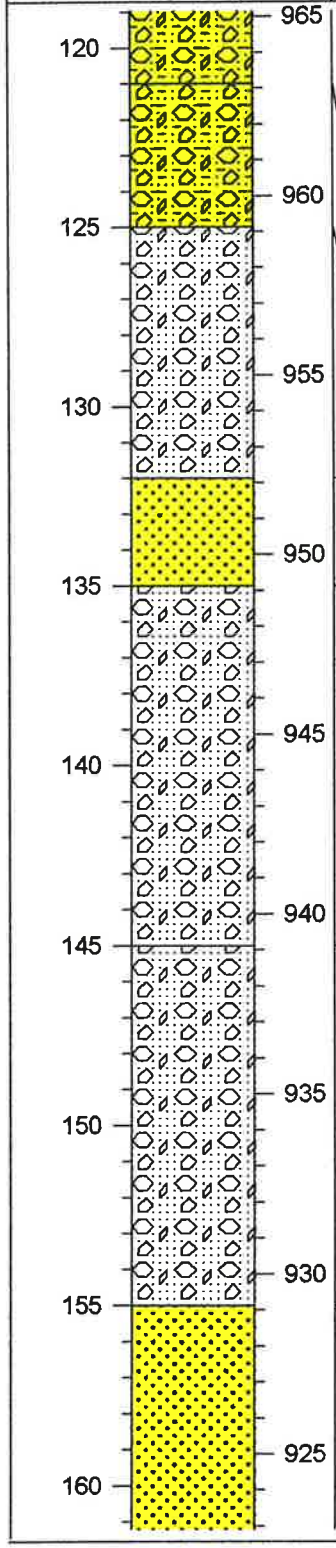
FIELD BOREHOLE LOG

BOREHOLE NO.: **Caisson**
TOTAL DEPTH: **175 feet**



DEPTH (feet)	ELEVATION (feet)	LITHOLOGY	RECOVERY	WELL CONSTRUCTION	WELL DESCRIPTION
120	965	Gray/Brown (silt), Silty Sand and Gravel, coarse sand, 70-80% fine to medium gravel, mostly fine, subangular to rounded, loose, appeared silty.	hold, prevent sample loss.		
125	960	Gray/Brown, Silty Sand and Gravel, medium to coarse sand, 50/50 mix, 20-40% fine gravel (trace medium to coarse), Silt.	125 to 135 feet, 7 feet recovery		
130	955	Gray, Sand and Gravel, medium to coarse sand, 50/50 mix, 20-30% fine gravel, subangular to rounded, loose, clean.			
135	950	Gray, Sand w/ Gravel, medium to coarse sand, mostly medium, 10% fine gravel, loose, clean.	135 to 145 feet, 10 feet recovery		
140	945	Gray, Sand and Gravel, medium to coarse sand, 50/50 mix, 20-30% fine gravel, subangular to rounded, loose, clean.			
145	940	As Above, slightly higher gravel content	145 to 155 feet, 10 feet recovery		
150	935				
155	930	Olive Gray, Sand, fine to medium sand, mostly fine, thin <1cm thick lignite fragment at top of interval. Driller noted harder drilling at 161 feet.	155 to 165 feet, 6 feet recovery, bottom 4' fell out.		
160	925				

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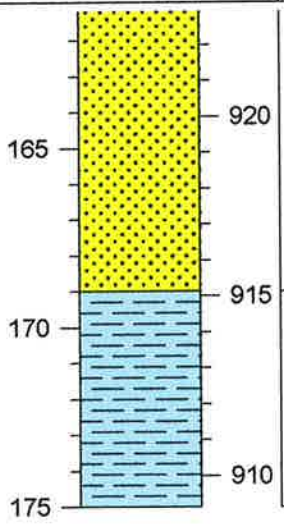
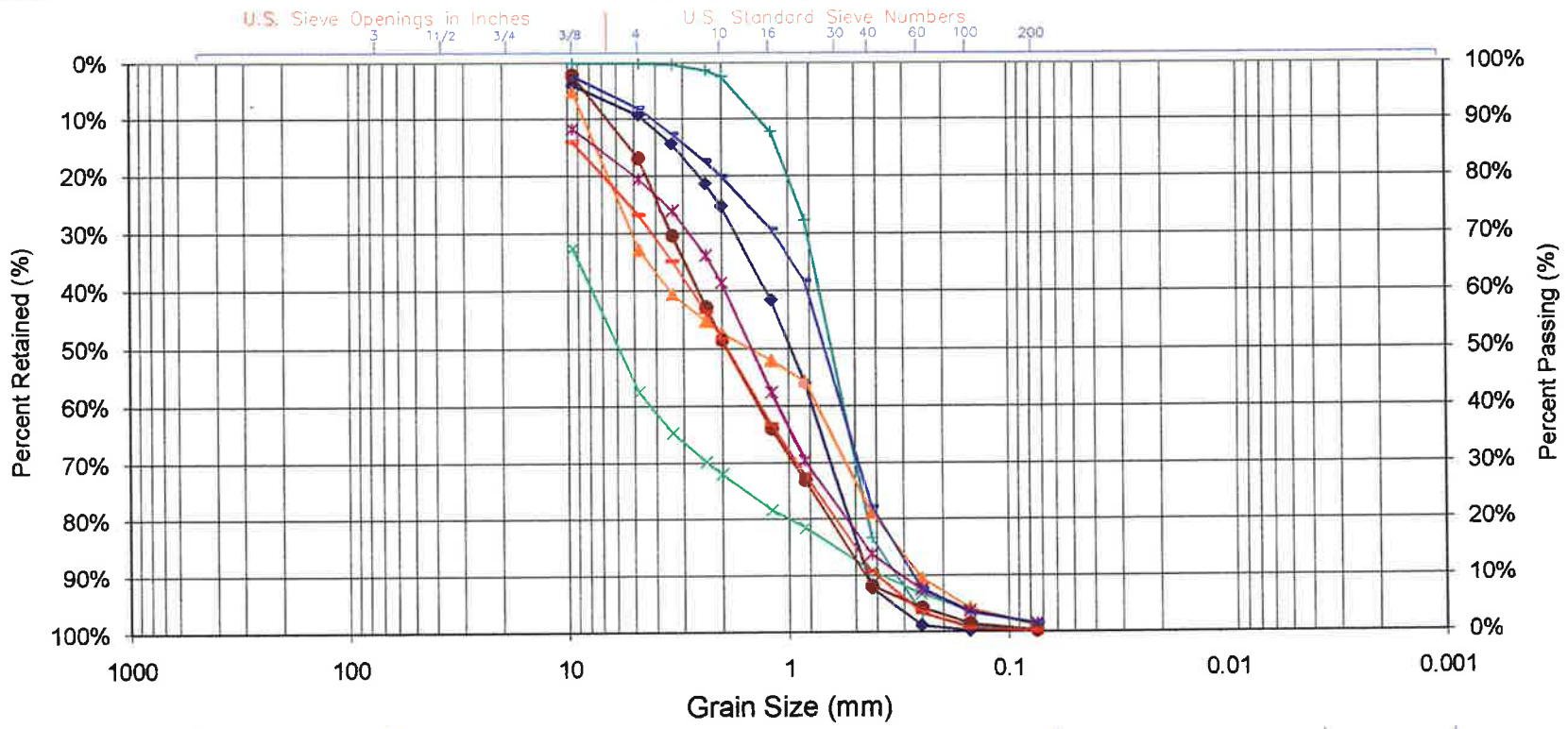
FIELD BOREHOLE LOG

BOREHOLE NO.: **Caisson**

TOTAL DEPTH: **175 feet**

DEPTH (feet)	ELEVATION (feet)	LITHOLOGY	RECOVERY	WELL CONSTRUCTION	WELL DESCRIPTION
165	920		165 to 175 feet, 10 feet recovery		
170	915	Bedrock, Weathered Red/Gray Shale.			
175	910				





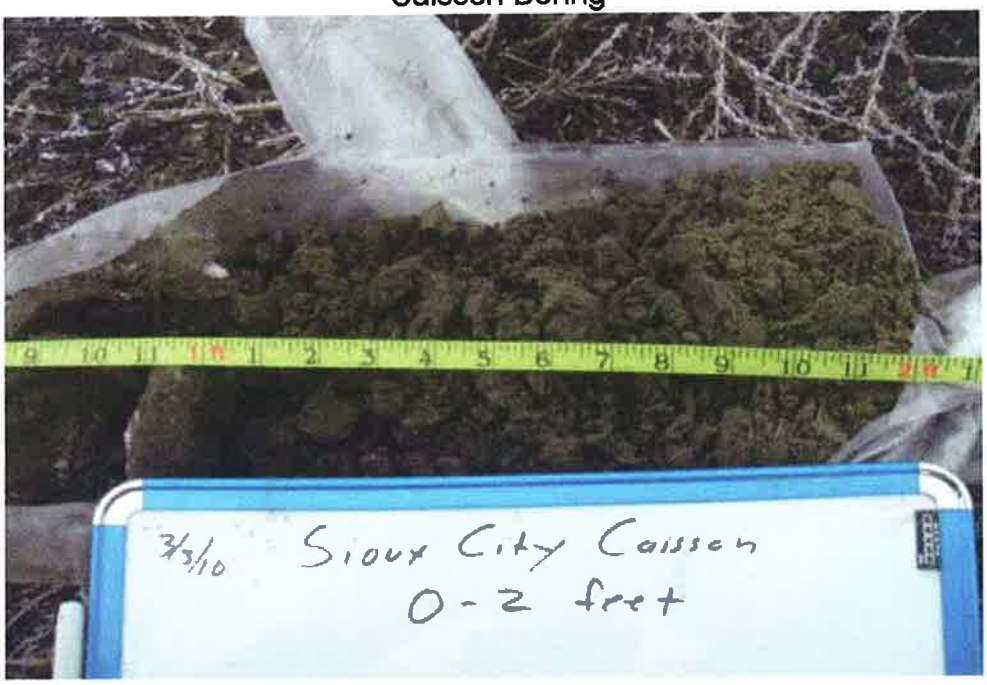
- Caisson 104-111
- Caisson 111-115
- Caisson 115-118
- Caisson 118-121
- Caisson 121-125
- Caisson 125-132
- Caisson 132-135
- Caisson 140-145

GRAIN SIZE ANALYSIS

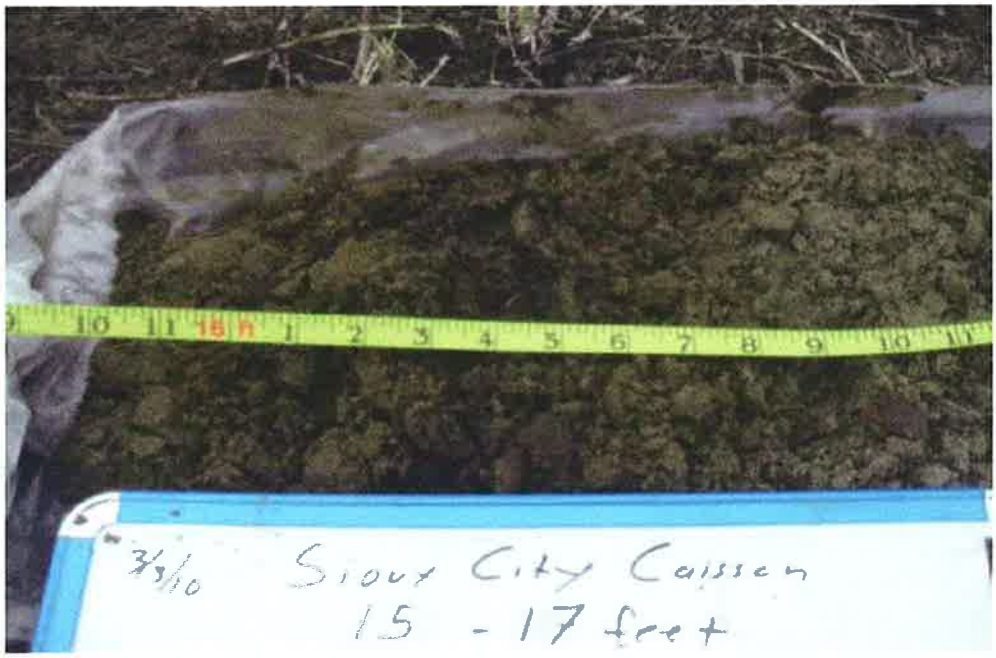
Ranney Collector Wells

Project: Sioux City / Southbridge Collector Well
Test Boring: Caisson
Job Number: 7390

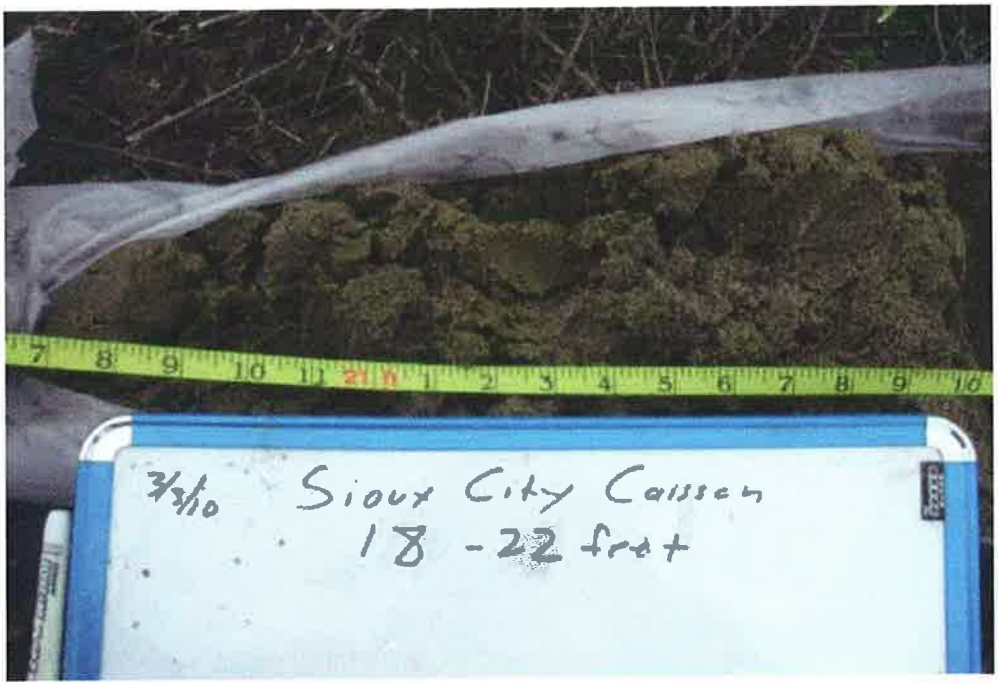
Southbridge Collector Well
Caisson Boring



Southbridge Collector Well
Caisson Boring



Southbridge Collector Well
Caisson Boring



Southbridge Collector Well
Caisson Boring

Southbridge Collector Well
Caisson Boring

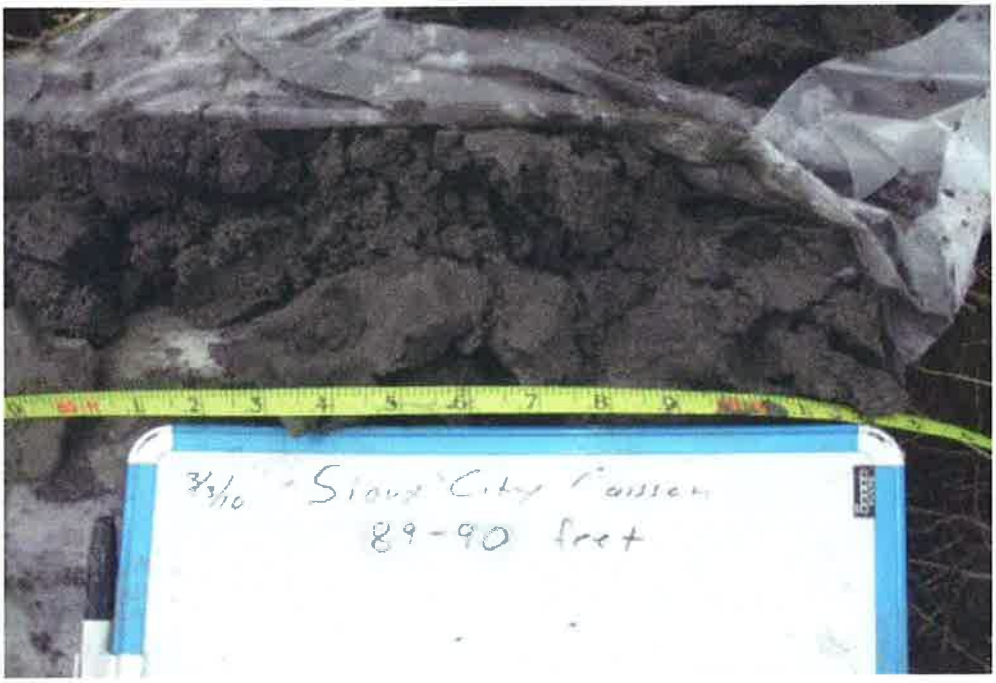
Southbridge Collector Well
Caisson Boring

66 - 67 feet

Southbridge Collector Well
Caisson Boring

80 - 85 feet

Southbridge Collector Well
Caisson Boring



Southbridge Collector Well
Caisson Boring

97 - 101 feet

Southbridge Collector Well
Caisson Boring

111 - 115 feet

118 - 121 feet

Southbridge Collector Well
Caisson Boring

130 - 132 feet

132 - 135 feet

Southbridge Collector Well
Caisson Boring

139.5 - 141.5 feet

143 feet

Southbridge Collector Well
Caisson Boring

149 - 151.5 feet

154 - 156 feet

Southbridge Collector Well
Caisson Boring

169-172

172-175